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(continued on next page)

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F16C 11/10

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E2F FAE FAF F115

(56) Documents Cited by ISA:
US 6148480 A
US 5649309 A
JP 2001177266 A
JP 2001207721 A
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JP 2001251396 A

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INT CL[7] F16C 11/10, H04M 1/02 1/23
Other: Jitsuyo Shinan Koho 1940-1996 Jitsuyo Shinan Toroku Koho 1996-2002 Kokai Jitsuyo Shinan Koho 1971-2002 Toroku Jitsuyo Shinan Koho 1994-2002

(54) Abstract Title: **Hinge structure with rotary actuator**

(57) In a hinge structure suitable for a twofold mobile telephone, at the opening initial stage, the pushing action of an operation member is converted by a cam-cam follower mechanism into the rotational motion of a hinge. Therefore, an unexpected reaction due to the inertial force acting between two portions to be opened can be avoided to ensure a suitable opening action without any shock. Especially, the hinge is biased in an opening direction by a spring force, so that the hinge is usually kept in a closed state by bringing the clutch coupling into engagement. That the hinge can be driven in the opening direction by the spring by pushing the operation member and releasing the clutch coupling.

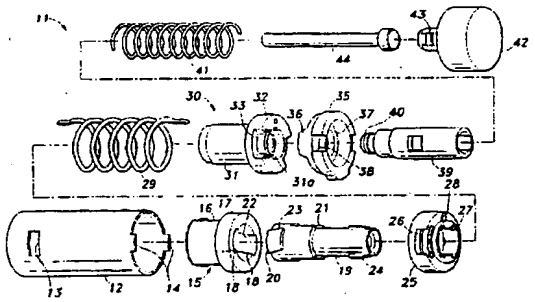

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Fig.1

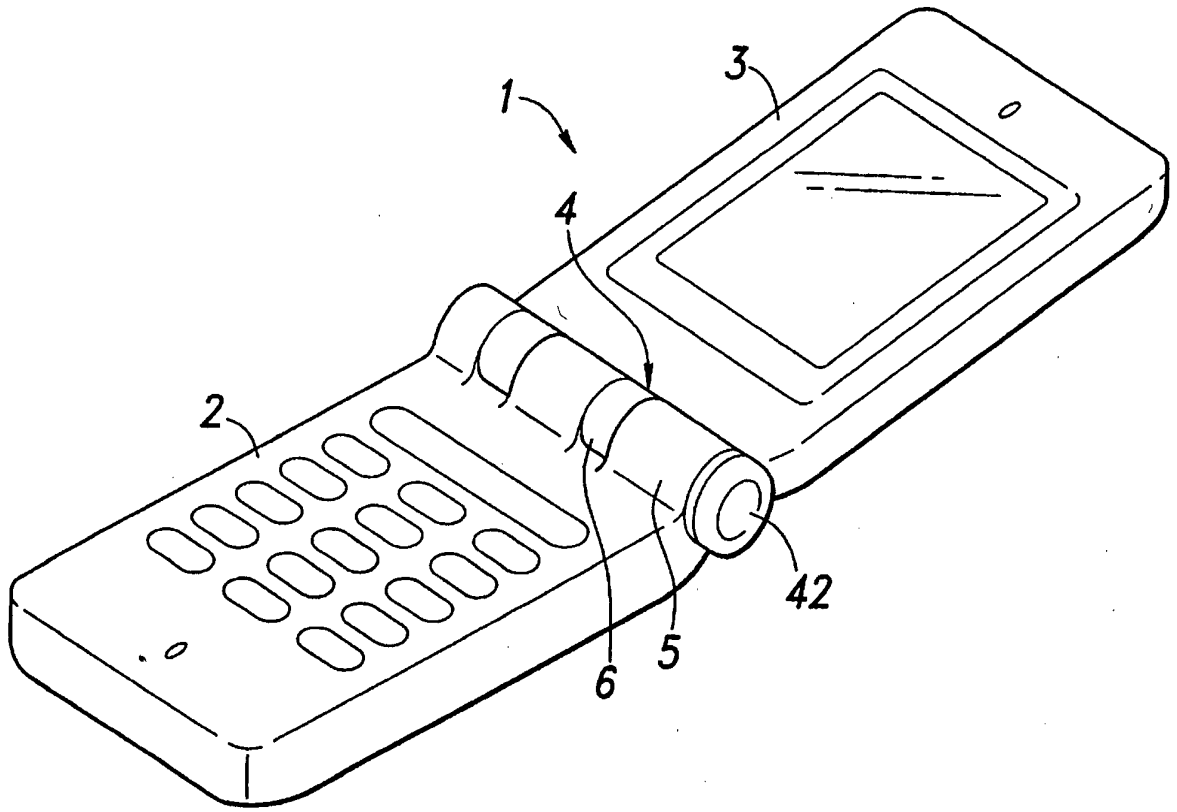

Fig.2

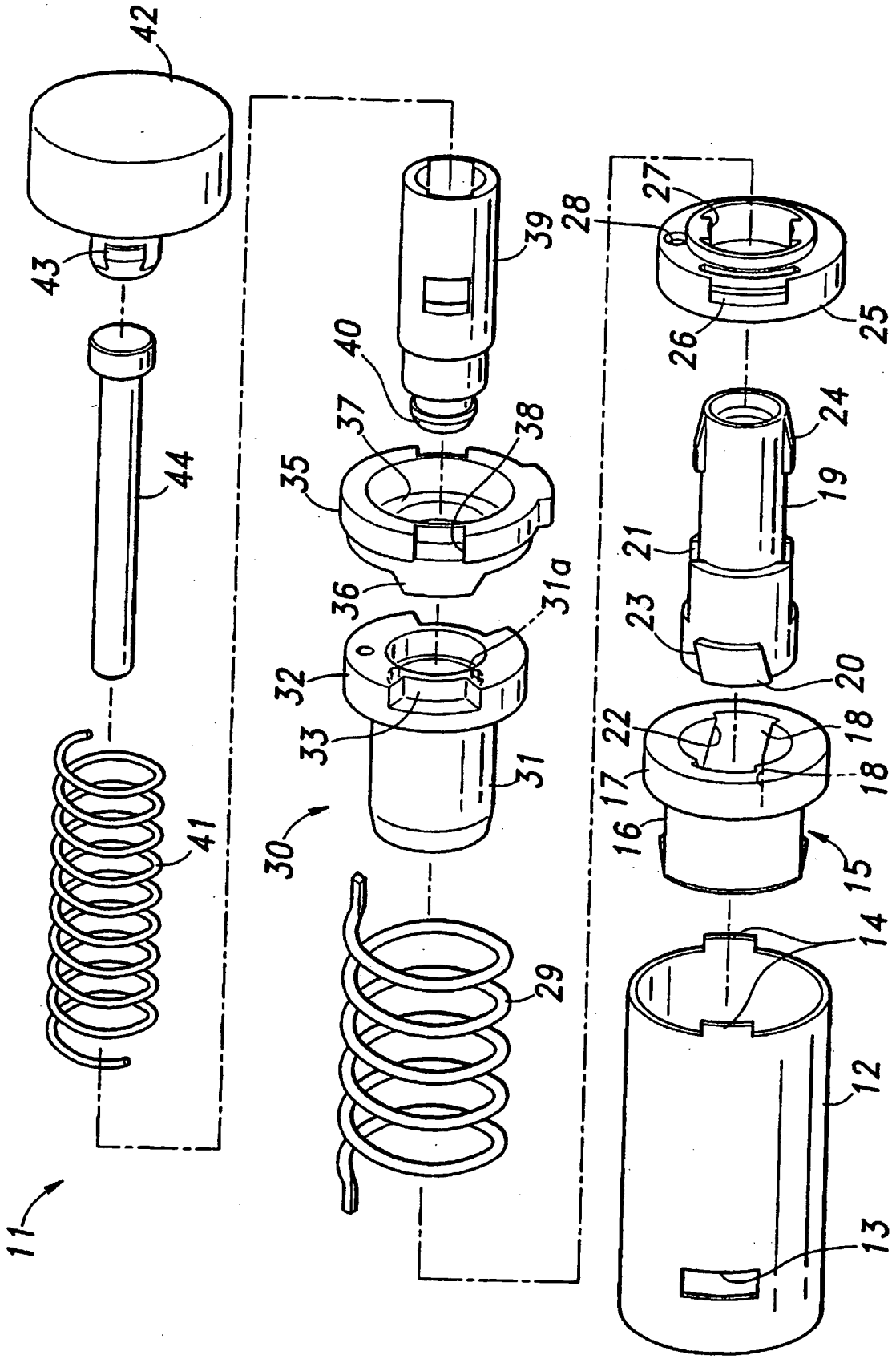
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Fig.3

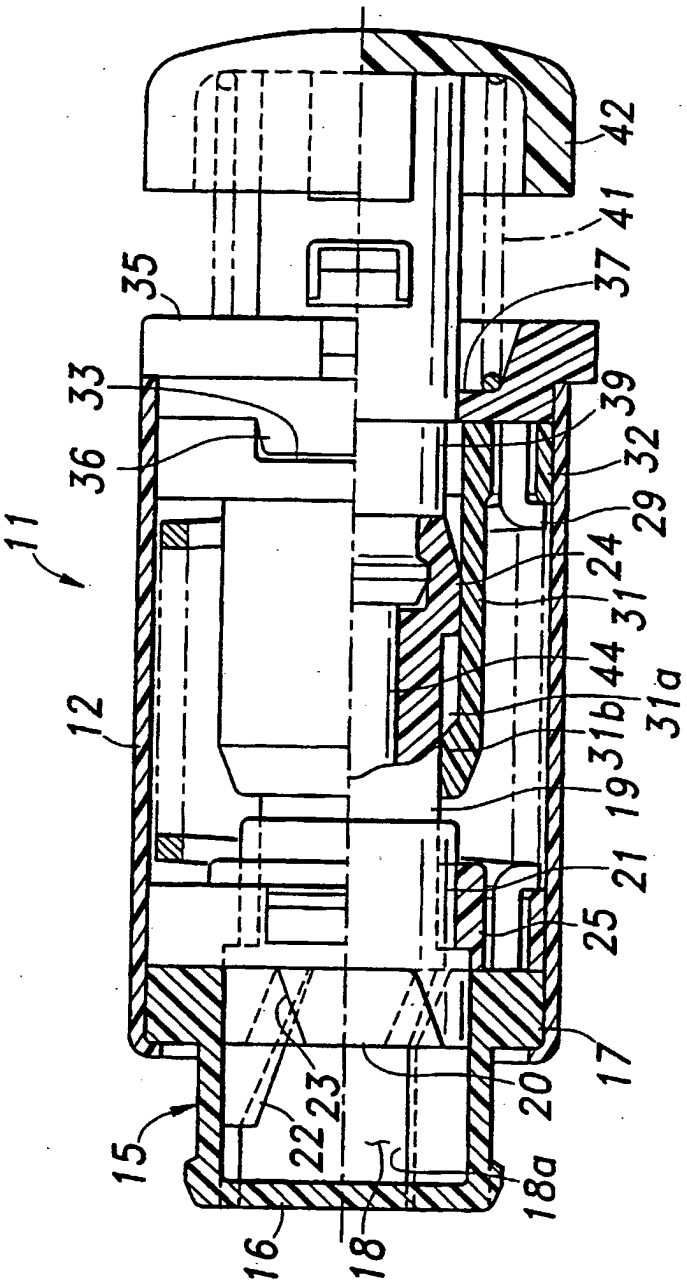
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Fig.4

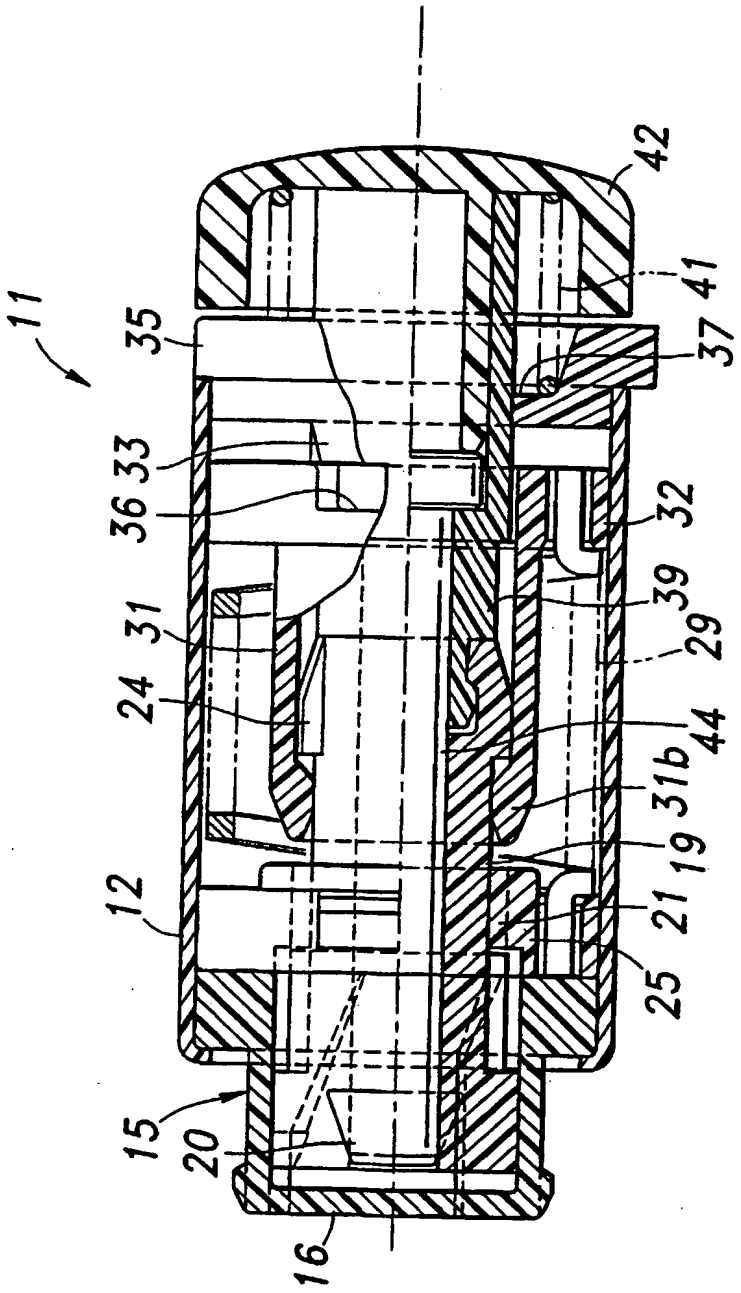
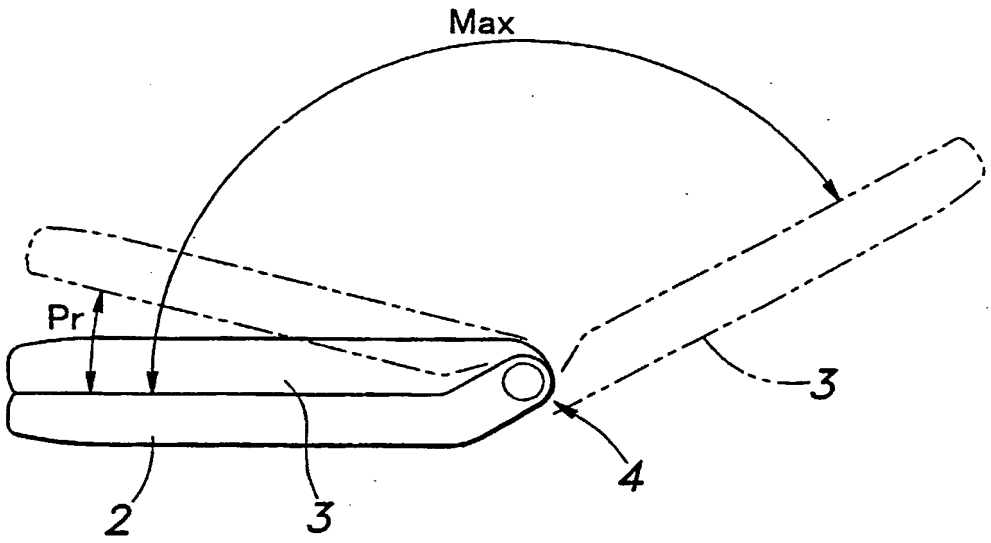


Fig.5



SPECIFICATION

TITLE OF THE INVENTION

HINGE STRUCTURE INCORPORATED WITH A ROTARY ACTUATOR

TECHNICAL FIELD

The present invention relates to a hinge for joining two members so as to be angularly moveable relative to each other, and in particular to a hinge structure incorporated with a rotary actuator and a spring drive mechanism so as to fold and unfold one member relative to the other.

BACKGROUND OF THE INVENTION

Many of the most current cellular phones are provided with a microphone unit and a speaker unit that are joined by a hinge so as to be unfolded in use and folded not in use. To increase the convenience of such a foldable telephone set, a hinge opening/closing device is disclosed in Japanese patent laid open publication 8-125725 that allows the two parts of the telephone set to be held in the closed or folded state in a stable manner and to be readily unfolded or opened using only one hand. In this hinge opening/closing device, a torsion coil spring is used for providing the rotational drive power to the hinge device.

However, the torsion coil spring stores the maximum amount of rotational energy when the two parts are fully folded, and this energy is released rapidly when a pushbutton is pressed to unfold the two parts so that the resulting reaction could cause a springy motion to the telephone set. Also, the retaining force that keeps the telephone set folded is related to the force required to operate the pushbutton. Therefore, when the retaining force is increased, the force required to operate the pushbutton increases, and this impairs the handling of the telephone set.

Such an inconvenience could be avoided by providing a suitable amount of frictional resistance by using a damper mechanism or weakening the spring force. However,

in either case, it is difficult to achieve a suitable initial operating speed, an adequately small operating force and a smooth operation over the entire stroke of operation.

BRIEF SUMMARY OF THE INVENTION

In view of such problems of the prior art, a primary object of the present invention is to provide a hinge structure that can be smoothly folded and unfolded by using a simple structure.

A second object of the present invention is to provide a hinge structure that is favorable for use in a foldable cellular or other mobile phone.

To achieve such objects, the present invention provides a hinge structure including a first part and a second part that are joined to each other so as to be angularly moveable relative to each other, comprising: an operating member axially slidably supported by the first part and having an axially projecting outer end; a first spring member urging the operating member in an outwardly projecting direction; a cam member connected to the operating member and supported by the first part in an axially slidable but rotationally fast manner; and a cam follower member fixedly attached to the second part and adapted to convert an axial movement of the operating member into a rotational movement of the second part relative to the first part.

Thus, because the initial unfolding movement of the hinge structure is effected by a manual action, an unexpected reaction arising from the inertia force acting between the two parts can be avoided from being transmitted to the user, and a highly favorable unfolding action free from a shock can be achieved.

By providing a second spring member that urges the second part in an unfolding direction relative to the first part, the unfolding action is improved even further. In particular, according to the present invention, the spring force of the second spring member may be set relatively weak so that the shock in unfolding the hinge can be reduced even

further.

According to a preferred embodiment of the present invention, the hinge structure further comprises a clutch that releases a rotationally fast engagement of the cam follower member relative to the first part via the cam member to place the cam follower member in a freely rotatable manner when the operating member is depressed beyond a prescribed stroke, and the clutch is adapted to retain the rotationally fast state of the cam follower member relative to the first part via the cam member when the first part and the second part are relatively folded one upon the other with the operating member left free. Thereby, an unfolding action relatively free from frictional resistance and a controlled folding action can be achieved so that both the folding and unfolding actions can be optimized.

In particular, it may be arranged such that the hinge is normally urged in the unfolding direction while the clutch is kept engaged to retain the hinge in the fully folded state, and that the hinge is resiliently driven in the unfolding direction by pushing the operating member and thereby disengaging the clutch.

BRIEF DESCRIPTION OF THE DRAWINGS

Now the present invention is described in the following with reference to the appended drawings, in which:

Figure 1 is an external perspective view of a mobile phone to which the present invention is applied;

Figure 2 is an exploded perspective view of the hinge of the mobile phone;

Figure 3 is a sectional view of the hinge when it is fully folded;

Figure 4 is a sectional view of the hinge when it is unfolded by pushing the pushbutton; and

Figure 5 is a schematic view showing the folding and unfolding action of the mobile phone.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows the external view of a mobile phone to which the present invention is applied. This mobile phone 1 comprises a microphone unit 2 provided with a keypad, a speaker unit 3 provided with a LCD panel, and a hinge 4 that joins these two units so as to be foldable relative to each other. The basic structure of the telephone set is per se known, and is omitted from the description given hereinafter.

Referring to Figures 2 and 3, a cylindrical housing 12 made of metal such as stainless steel and having an inner diameter of approximately 7.4 mm is provided with an inwardly directed radial flange in a left open end thereof in the drawings. This flange is formed by drawing, and performs the function of retaining inner components in place. In the left end of the housing 12 is retained a cam follower member 15 that comprises a main part 16 having a relatively small diameter and projecting out of the open left end of the housing 12 and a flange portion 17 that engages the radial flange of the housing 12. The cam follower member 15 is generally cup-shaped, and a pair of spiral cam grooves 18 are formed on the inner circumferential surface thereof in a mutually symmetric relationship with respect to a central axial line as will be described in more detail hereinafter.

An annular retaining member 25 is received in the housing 12 and abuts the right end of the cam follower member 15. A pair of projections 26 formed on the outer circumferential surface of the retaining member 25 engage corresponding openings 13 of the housing 12 so as to retain the cam follower member 12 in a rotatable but axially fast manner, and retain the retaining member 25 in both rotationally and axially fast manner. The right end of a cylindrical cam member 19 is passed into and retained in the inner bore of the retaining member 25, and the left end of the cam member 19 fits slightly into the right end of the cam follower member 15. Under this condition (the unfolded state of the hinge), a pair of cams 20 formed in the cam member 19 slightly engage the cam grooves 18.

As will be described hereinafter, as the cam member 19 moves leftward, the left end of the cam member 19 moves deeper into the cam follower member 15, and the cam follower member 15 rotates relative to the cam member 19 by virtue of the cooperation between the cams 20 and cam grooves 18. A pair of projections 27 are formed on the inner circumferential surface of the retaining member 25, and engage axial grooves 21 formed in an intermediate part of the cam member 19. Each axial groove 21 has a prescribed length so that the projections 27 of the retaining member 25 engage the axial grooves 21 of the cam member 19 so as to retain the cam member 19 in a rotationally fast manner when the depth by which the left end of the cam member 19 is received in the cam follower member 15 is less than a prescribed value. When the depth by which the left end of the cam member 19 is received in the cam follower member 15 becomes greater than the prescribed value, the projections 27 are disengaged from the cam member 19 so that the cam member 19 is allowed to rotate freely.

The cam grooves 18 of the cam follower member 15 and the cams 20 of the cam member 19 engage with each other via cam slopes 22 and 24 having such a spiral angle that an axial movement of the cam member 19 into the cam follower member 15 by a prescribed stroke (1.6 mm, for instance) causes a rotation of the cam follower member 15 by a corresponding angle (10 degrees, for instance). The cam grooves 18 of the cam follower member 15 include linear sections 18a so that the axial movement of the cam member 19 would cease to be converted into a rotational movement of the cam follower member 11 once the cams 19 have advanced in the cam grooves 18 beyond a prescribed distance (1.6 mm, for instance). The total axial stroke of the cam member 19 is approximately 2.4 mm.

The right end of the cam member 19 is passed into a hollow and cylindrical clutch member 30 that comprises a main part 31 disposed on the left end thereof and provided with a relatively small diameter and a flange portion 32 provided on the right end thereof. The

right end of the cam member 19 is provided with a pair of projections 24 that engage corresponding axial grooves 31a provided in the inner bore of the clutch member 30 so that the cam member 19 and clutch member 30 are axially slidable relative to each other but rotationally fast with each other. The axial grooves 31a terminate near the left end of the clutch member 30, and define inner engagement portions 31b so that when the cam member 19 is pushed inward in the clutch member 30 by more than a prescribed stroke, the clutch member 30 starts to be forced leftward by the cam member 19 by virtue of the engagement between the inner engagement portions 31b and projections 24.

The right end of the clutch member 30 is engaged by a lid member 35 that is in turn engaged by the axial end of the housing 12 via an annular shoulder formed along the outer periphery of the lid member 35. By crimping tabs 14 formed at the axial end of the housing 12 onto corresponding recesses 38 formed around the outer periphery of the lid member 35, the lid member 35 is integrally secured to the housing 12.

A torsion coil spring 29 is interposed between the retaining member 25 and the flange portion 32 of the clutch member 30 to rotationally urge the clutch member 30 and axially urge the clutch member 30 toward the lid member 35. The axial ends of the coil wire of the torsion coil spring 29 extend axially and fit into axial holes 28 and 34 provided in the retaining member 25 and the flange portion 32 of the clutch member 30, respectively. A pair of axially projecting engagement projections 36 are provided in the inner end of the lid member 35 facing the housing at diametrically opposing positions, and normally (when the hinge is fully folded or unfolded) fit into corresponding recesses 33 of the flange portion 32 of the clutch member 30 to prevent the rotation of the clutch member 30.

A cylindrical connecting member 39 is passed into the central holes of the lid member 35 and clutch member 30, and the free end or left end of the connecting member 39 snap fits into the central hole of the cam member 19 formed on the right end thereof so that

the cam member 19 and connecting member 39 are axially joined to each other for integral axial movement.

A compression coil spring 41 is resiliently interposed between an annular shoulder surface formed on the inner periphery of the outer end surface of the lid member 35 and pushbutton 42. A metallic rod 44 is passed into the central bore of the connecting member 39 to transmit the force that pushes the pushbutton 42 inward to the cam member 19 in a reliable manner and with an adequate mechanical strength.

The mode of operation of the hinge incorporated with a rotary actuator according to the present invention is described in the following additionally with reference to Figure 4.

When the speaker unit 3 is folded onto the microphone unit 2, the clutch member 30 is pushed rightward by the axial force of the torsion coil spring 29. Under this condition, the projections 36 of the lid member 35 are in engagement with the recesses 32 of the clutch member 30 (the engaged state of the clutch) so that the clutch member 30 is kept rotationally immobile with respect to the housing 12 even though the torsion coil spring 29 applies a rotational force to the clutch member 30. A clutch is thus formed by the projections 36 of the lid member 35, recesses 32 of the clutch member 30 and torsion coil spring 29.

The cam member 19 which is connected to the clutch member 30 so as to be rotationally fast but axially slidable within a prescribed range relative to the clutch member 30 is displaced fully rightward under the axial force of the compression coil spring 41 acting on the pushbutton 42. Furthermore, in this state, the cam member 19 is rotationally fast with the retaining member 25 by virtue of the engagement between the axial grooves 21 and projections 27. Therefore, the cam follower member 15 which is in engagement with the cams 20 on the left end of the cam member 19 is rotationally immobile. Thereby, the speaker unit 3 and microphone unit 2 are kept folded one upon the other.

When the pushbutton 42 is pushed leftward by a small stroke (1.6 mm) under this condition, the connecting member 39 integrally joined to the pushbutton 42 moves leftward, and the cam member 19 connected to the inner end of the connecting member 39 moves leftward. Because the cam member 19 is kept rotationally fast relative to the retaining member 25 by virtue of the engagement between the axial grooves 21 and projections 27, the cams 20 on the left end of the cam member 19 move axially leftward without rotating. Therefore, by the action of the cam slopes 22 and 23 defined by the cam grooves 18 and cams 20, the cam follower member 15 rotates. This rotation causes the speaker unit 3 that is integrally connected to the cam follower member 15 to open or unfold by an angle of approximately 10 degrees (angle Pr in Figure 5).

As the pushbutton 42 is pushed further, the cams 20 of the cam member 19 eventually reach the linear sections 18a of the cam grooves 18 of the cam follower member 15, and the cam follower member 15 ceases to rotate any further. On account of the engagement between the inner engagement portions 31b and projections 24, the continued axially inward movement of the cam member 19 causes the clutch member 30 to move leftward. When the pushbutton 42 has been fully depressed, the projections 36 of the flange 28 of the clutch member 30 disengage from the recesses 33 of the lid member 35 (the disengaged state of the clutch), and the rotationally fast engagement between the retaining member 25 and cam member 19 owing to the engagement between the projections 27 of the retaining member 25 and the axial grooves 21 of the cam member is released at the same time.

As a result, the rotational biasing force of the torsion coil spring 29 normally acting upon the clutch member 30 is released. Because the cam grooves 18 of the cam follower member 15 and cams 20 of the cam member 19 are in a rotationally fast engagement with each other, and cam member 19 and the clutch member 30 are also in a

rotationally fast engagement with each other, the clutch member 30, cam member 19 and cam follower member 15 all rotate in a single body. In other words, the microphone unit 2 and speaker unit 3 automatically unfold relative to each other. The maximum unfolding angle (indicated by MAX in Figure 5) is determined by the mechanically defined unfolding angle of the hinge 4.

Under this condition, because the projections 36 ride over the end surface of the flange 32, the clutch member 30 is prevented from moving rightward in spite of the axial biasing force of the torsion coil spring 29. Similarly, because a rotation preventing means 24 provided between the cam member 19 and the retaining member 25 is at a mismatched phase relationship, the cam member 19 is prevented from moving rightward in spite of the axial biasing force of the compression coil spring 36. As a result, the unfolded state of the hinge is maintained as long as no external force is applied thereto. Under this condition, the pushbutton 42 remains in the fully depressed state.

When the microphone unit 2 and speaker unit 3 are manually folded one over the other against the rotational biasing force of the torsion coil spring 29, the cam follower member 15 and cam member 19 initially rotate together, but once the phase relationship between the projections 27 of the retaining member 25 and axial grooves 21 of the cam member 19 matches up, the axial force of the compression coil spring 36 forces the projections 27 and axial grooves 21 into alignment, and the cam member 19 is forced rightward. At this time, because the cams 20 are engaged by the linear sections 18a of the cam grooves 18, no rotational force is applied to the cam member 19.

Because the rightward axial biasing force of the torsion coil spring 29 normally acts upon the clutch member 30, once the projections 36 of the lid member 35 and recesses 33 of the flange 32 come into alignment with each other, and the clutch becomes engaged. As a result, the rotational biasing force of the coil spring 29 is kept in check. The axial

biasing force of the compression coil spring 36 forces only the cam member 19 further rightward, and the cam follower member 15 rotates under the action of the cam slopes 22 and 23 until the microphone unit 2 and speaker unit 3 are completely folded one over the other. Under this condition, the axial biasing force of the compression coil spring 36 keeps the two units in the fully folded state, and the pushbutton 42 is brought back to the fully projecting state.

According to the embodiment described above, a high level of convenience can be achieved for a device that can be folded because the two parts that are mutually folded one over the other are partly unfolded by slightly depressing the pushbutton, and are fully unfolded automatically under the biasing force of a torsion spring by further depressing the pushbutton. The two parts can be folded in the same manner as the conventional device. In particular, the unfolding action takes place in two stages, first by the manual force applied to the pushbutton and transmitted to the cam, and second by the force of the spring. Therefore, the shock when initially unfolding the hinge can be minimized as compared with the convention hinge that relies on the spring force for the initial unfolding action, and the necessary spring force can be reduced because the spring force is not relied upon for the initial unfolding torque. Furthermore, because the hinge is incorporated with a rotary actuator as an independent unit, the same actuator can be used for a number of different devices, and a significant advantage can be gained in simplifying the manufacturing process and components management.

INDUSTRIAL APPLICABILITY

The foregoing description was directed to an application to a mobile telephone set, but the present invention can also be applied to a hinge device for connecting a keyboard unit and a display unit in a laptop computer, and a hinge device for connecting a lid to a main body of a container. The folded state was the normal state in the foregoing

embodiment, but the unfolded state may also be the normal state and the hinge may be adapted to automatically fold by suitably selecting the position for engaging the clutch and direction of the torsional biasing force. Additionally, by combining a per se known rotary damper using viscous fluid, an even more smooth action can be achieved.

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CLAIMS

1. A hinge structure including a first part and a second part that are joined to each other so as to be angularly moveable relative to each other, comprising:

an operating member axially slidably supported by said first part and having an axially projecting outer end;

a first spring member urging said operating member in an outwardly projecting direction;

a cam member connected to said operating member and supported by said first part in an axially slidable but rotationally fast manner; and

a cam follower member fixedly attached to said second part and adapted to convert an axial movement of said operating member into a rotational movement of said second part relative to said first part.

2. A hinge structure according to claim 1, further comprising a clutch that releases a rotationally fast engagement of said cam follower member relative to said first part via said cam member to place said cam follower member in a freely rotatable manner when said operating member is depressed beyond a prescribed stroke.

3. A hinge structure according to claim 2, wherein said clutch is adapted to retain the rotationally fast state of said cam follower member relative to said first part via sad cam member when said first part and said second part are relatively folded one upon the other with said operating member left free.

4. A hinge structure according to claim 3, further comprising a second spring

member that urges said second part in an unfolding direction relative to said first part

5. A hinge structure according to claim 3, wherein said second spring member is additionally adapted to retain said clutch in a rotationally fast manner.

6. A hinge structure according to claim 4, wherein said second spring member consists of a torsion coil spring.

7. A hinge structure according to claim 4, wherein said cam follower member is adapted to effect only a part of the relative rotational movement between said first and second parts.

8. A hinge structure according to claim 4, further comprising a second spring member that urges said second part in an unfolding direction relative to said first part

9. A hinge structure according to claim 4, wherein said first part comprising a cylindrical housing, and said second spring member consists of a torsion coil spring received in said housing.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/02693

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F16C11/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F16C11/10; H04M1/02-1/23

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1940-1996	Jitsuyo Shinan Toroku Koho	1996-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Toroku Jitsuyo Shinan Koho	1994-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	JP 2001-177266 A (Kato Denki Kabushiki Kaisha), 29 June, 2001 (29.06.01), Page 4, left column, lines 30 to 45 (Family: none)	1-9
P,X P,A	JP 2001-207721 A (Kato Denki Kabushiki Kaisha), 03 August, 2001 (03.08.01), Page 3, right column, line 49 to page 4, left column, line 19 (Family: none)	1 2-9
E,X E,A	JP 2002-89542 A (Kato Denki Kabushiki Kaisha), 27 March, 2002 (27.03.02), Page 4, left column, lines 10 to 31 (Family: none)	1 2-9

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
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"E" earlier document but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 May, 2002 (09.05.02)	21 May, 2002 (21.05.02)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/02693

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5649309 A (Motorola Inc.), 15 July, 1997 (15.07.97), & JP 9-181806 A & GB 2300880 A & FR 2734440 A	1-9
A	US 6148480 A (NEC Corp.), 21 November, 2000 (21.11.00), & JP 11-341130 A & GB 2334068 A & AU 1544199 A	1-9